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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/986,332	11/08/2001	Hiroyuki Kiyoku	Q66212	5542

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EXAMINER
ANDERSON, MATTHEW A

ART UNIT	PAPER NUMBER
1765	7

DATE MAILED: 12/19/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/986,332	Applicant(s) KIYOKU ET AL.	
	Examiner Matthew A. Anderson	Art Unit 1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08 November 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4,6,8-12,16,17,23,25 and 189-197* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,6,8-12,16,17,23,25 and 189-197* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *08 November 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. *09/202,141* .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 U.S.C. 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-4, 6, 8-9, 12, 16, 23, 189-190, 193-196 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. (WO 97/11518) in view of Takeuchi et al. (US 5,239,188).

The examiner has used the disclosure of US 6,377,596 B1 as a translation of the PCT publication.

Tanaka et al. discloses a method for growing a low defect monocrystalline defect monocrystalline layer over a mask. In Fig. 16 and in col. 28 lines 34+ the method is described. Striped openings in a insulator mask are formed on the (0001) plane of a sapphire substrate. (in col. 19 lines 65 is suggested that such stripes be formed in the direction parallel to the (11-20) A plane of a sapphire substrate. Perpendicular stripes to the (11-20) plane are also disclose in col. 11 line 55.) A GaN buffer layer is formed

in the spaces between the stripes. N-type GaN is grown from the spaces laterally until it covers the mask between them (i.e. coalesces). The growth is described as by MOVPE. The defect density obtained is disclosed in col. 32 as 10^4 to 10^5 defects per cm^2. MOVPE is described in col. 17 and 18 in which a tri-methyl gallium is reacted with ammonia to form the GaN. The substrate is disclosed as sapphire (Al2O3) or SiC. The insulator making up the mask was disclosed in col. 5 lines 65+ and col. 6 lines 1-5 as amorphous material such as SiO2, Si3N4, PSG, SION, or Ta2O3. The relative size of the spaces is seen in Fig. 16 B to less than that of the mask layers.

Takeuchi et al. discloses a gallium nitride base semiconductor device. In Fig. 4A,4B,4C, and 4D is shown a epitaxial overgrowth of GaN on a Si substrate using a AIN mask layer. In Col. 3 lines 35-50, it is disclosed that the nitride semiconductor will also deposit on a thin AIN buffer layer on a sapphire substrate. In Fig. 3 is shown a n-GaN single crystal. In Fig. 4C is seen the growth of GaN from the sides of the recesses in the overlying AIN layer.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the disclosures of the references cited to yield a method of forming a gallium nitride semiconductor as disclosed in Claim 1 because the use of nitride buffer layers (i.e. a nitride underlayer) on a sapphire substrate to reduce defects and the use of mask layers for epitaxial overgrowth and recombination where known in the art.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to form a nitride semiconductor as disclosed in Claim 1 with defect

less than 10^5 per cm^2 because the use of nitride buffer layers (i.e. a nitride underlayer) on a sapphire substrate to reduce defects and the use of mask layers for epitaxial overgrowth and recombination where known in the art .

It would have been obvious to one of ordinary skill in the art at the time of the present invention present invention to form the growth mask such that the area of the covered portion of the underlayer (i.e. buffer layer) is larger than the area exposed in the windows because such an arrangement is suggested in Tanaka et al. in view of the universal buffer suggested by Takeuchi et al.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to form the growth mask such that it is made up of a plurality of stripes spaced apart and parallel to one because such an arrangement is suggested in Tanaka et al.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to form the growth mask such that the area of the covered portion is larger than the area exposed in the windows because such an arrangement is suggested by Tanaka et al.

It would have been further obvious to one of ordinary skill in the art to optimize the process parameters of width of the windows, the ratio of the width of the stripes to the width of the windows, and thickness of nitride layer grown because these process parameters were suggested in the art and their optimization would have required only routine experimentation.

In respect to claim 16, it would have been obvious to one of ordinary skill in the art to dope the first nitride semiconductor with an n-type impurity because such a doping was known in the art (Takeuchi et al.).

In respect to claim 9,it would have been obvious to one of ordinary skill in the art at the time of the present invention to use a sapphire (0001) substrate with stripes perpendicular to the (11-20) plane for the lateral epitaxy because this is suggested by Tanaka et al.

In respect to claim 12, it would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the process parameters of crystallographic orientation of the sapphire substrate and the direction in which the mask stripes extend because the (11-20) and the (1-120) planes were known in the art and such optimization would have been achieved with routine experimentation.

It would have been obvious to one of ordinary skill in the art to grow the first nitride portion by metal-organic vapor phase epitaxial method because Tanaka et al. suggests such a growth method in a lateral overgrowth method.

3. Claims 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka in view of in view of Takeuchi et al., and further in view of Harunori et al. (JPO 07201745A).

Tanaka combined is disclosed above.

Tanaka et al. . does not explicitly disclose methods of off-angling or off-angling step wise.

Harunori et al. disclose a method of off-angling by several degrees in a step wise fashion.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to off-angle the major surface because such an arrangement of the major surface was known in the art for (0001) sapphire substrates and because such an arrangement would have been anticipated to produce an expected result.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to off-angle stepwise the major surface because such an arrangement of the major surface was known in the art for (0001) sapphire substrates .

4. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. in view of Takeuchi et al as applied to the claims above, and further in view of Larkin et al. (US 5,709,745).

Tanaka et al. suggests a method of fabricating a nitride semiconductor on a sapphire substrate having a major surface forming the (0001) plane and doping of the nitride semiconductor grown over the mask with n-type doping.

Tanaka combined does not suggest doping such that the doping concentration decreases with an increase in distance from the substrate.

Larkin et al. discloses a method of controlling the amount of impurity incorporation in a crystal growth by chemical vapor deposition. The method includes controlling the concentration of the crystal growing components in the growth chamber to affect the demand of particular sites within the growing crystal thereby controlling

impurity incorporation. The method is described as useful with n-type dopants in line 20-45 in Col. 16. The method is described as useful for III-V compound semiconductors such as GaAs, InP, InGaAs, GaAsP, GaP, InAs, InGaAsP, etc.
The Examiner notes that GaN is a III-V compound semiconductor. In Col. 8 the profile of the doping concentration within a crystal is described as controlled by affecting the ratios of the crystal growing components.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to add the n-type impurity such that the doping concentration decreases with an increasing distance from the substrate because Larkin et al. discloses a method by which the dopant concentration profile would be controlled.

5. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. in view of Takeuchi et al., as applied to the claims above, and further in view of Nitta et al. (US 5,789,265).

Tanaka et al. suggest a nitride semiconductor growth method using a mask and metal organic vapor phase epitaxial method.

Tanaka . does not explicitly suggest using a halide vapor epitaxial method to grow a second nitride semiconductor portion on the first nitride portion.

Nitta et al. in Col. 6 lines 35-45 suggests using MO-CVD, halide CVD, MBE (Molecular beam epitaxy) to grow various nitride semiconductor layers with and with out doping.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine MOCVD and halide CVD to grow the nitride layers because both methods were known in the art, both were used previously in the art to grow nitride based semiconductors on sapphire (Nitta et al.) and because such a combination of growth methods would have yield nitride semiconductor layers.

6. Claims 191-192 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. and of Takeuchi et al., as applied to the above, and further in view of Mauk et al. (US 5,828,088).

Tanaka et al. are discussed above.

Tanaka et al. do not explicitly suggest a multi-layer mask.

Mauk et al. discloses multi-layer masks for epitaxial lateral overgrowth. The masks are made from combinations of dielectrics semiconductors, and metals including metal silicides, metal oxides, metal carbides, metal nitrides, and cermets. The examiner notes that TiO2 and SiO2 fall within the metal oxide category.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine because the multi-layer mask of Mauk prevents adverse reaction with the semiconductor grown.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a multi-layer mask comprised of SiO2 and TiO2 because both were well known metal oxides and Mauk et al suggests the use of metal oxide multiplayer masks in lateral overgrowth epitaxy.

7. Claim 197 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. and of Takeuchi et al. as applied to the claims above, and further in view of Goossen (US 6,172,417 B1) .

Tanaka et al does not suggest removing the support member.

Goossen suggest removing the substrate from an epitaxially formed layer after the deposition process to remove mechanical constraints on the epitaxial material. Col. 5 lines 50-60.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the references because then nitride substrate with lowered mechanical constraints would have been produced.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to removed the support structure (i.e. substrate) from a laterally overgrown nitride because such growth was suggested y Tanaka et al. and such a removal to reduce mechanical constraints on an epitaxial layer were suggested by Goossen.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew A. Anderson whose telephone number is (703) 308-0086. The examiner can normally be reached on M-Th, 6:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on (703) 308-3836. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

MAA
December 13, 2002

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